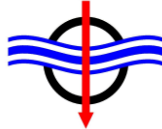




Belstead



Demise by Design

James Beck, Ian Holbrough, Belstead Research Ltd;
Alan Flinton, Andrew Hyslop, Fluid Gravity Engineering Ltd;
Thorn Schleutker, Dominik Neeb, Agastya Parikh, DLR;
Scott Walker, University of Southampton
Clean Space Days, Noordwijk
29th June – 3rd July 2026
PR00117/D62

Introduction

- Design for Demise
 - Increase component demise by reducing required heat
 - Decrease mass
 - Change material
 - Increase component demise by increasing heat flux/load
 - Early exposure / fragmentation
 - Direct addition of heat (thermite)
- Demise by Design
 - Can we design simple geometric features in to enhance demise?
 - Reduce length scales, more leading edges, increase gradients

Introduction

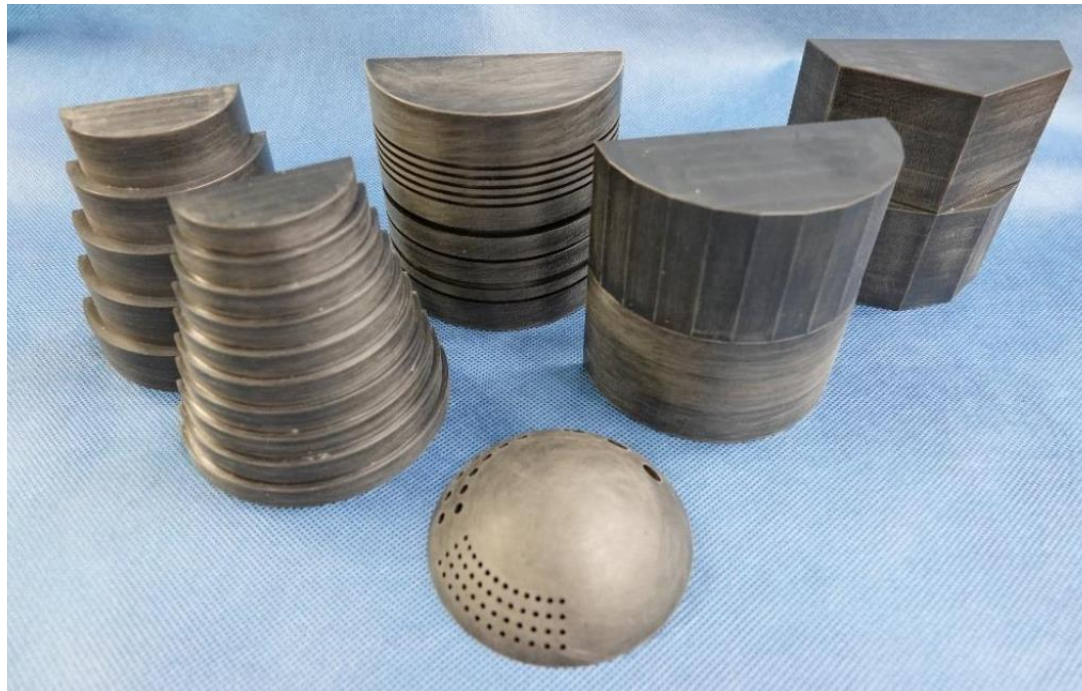
- Demise by Design
 - OSIP Early Technology Development
 - Belstead Research – Lead / analysis / modelling
 - Fluid Gravity Engineering – Aerothermodynamics
 - DLR – Wind tunnel testing (H2K and L2K)
 - University of Southampton – Structural analysis

Approach

- Identify a Set of Candidate Features
 - No change to functional elements
 - Small surface features
- Testing of Features
 - Test candidate shapes in DLR H2K cold tunnel
 - PEEK model; assess heating with IR thermography
 - Down select candidates for demonstration testing
 - Test most promising shapes in DLR L2K hot tunnel
 - Confirm heating augmentation
 - Attempt quantitative analysis of shape effects

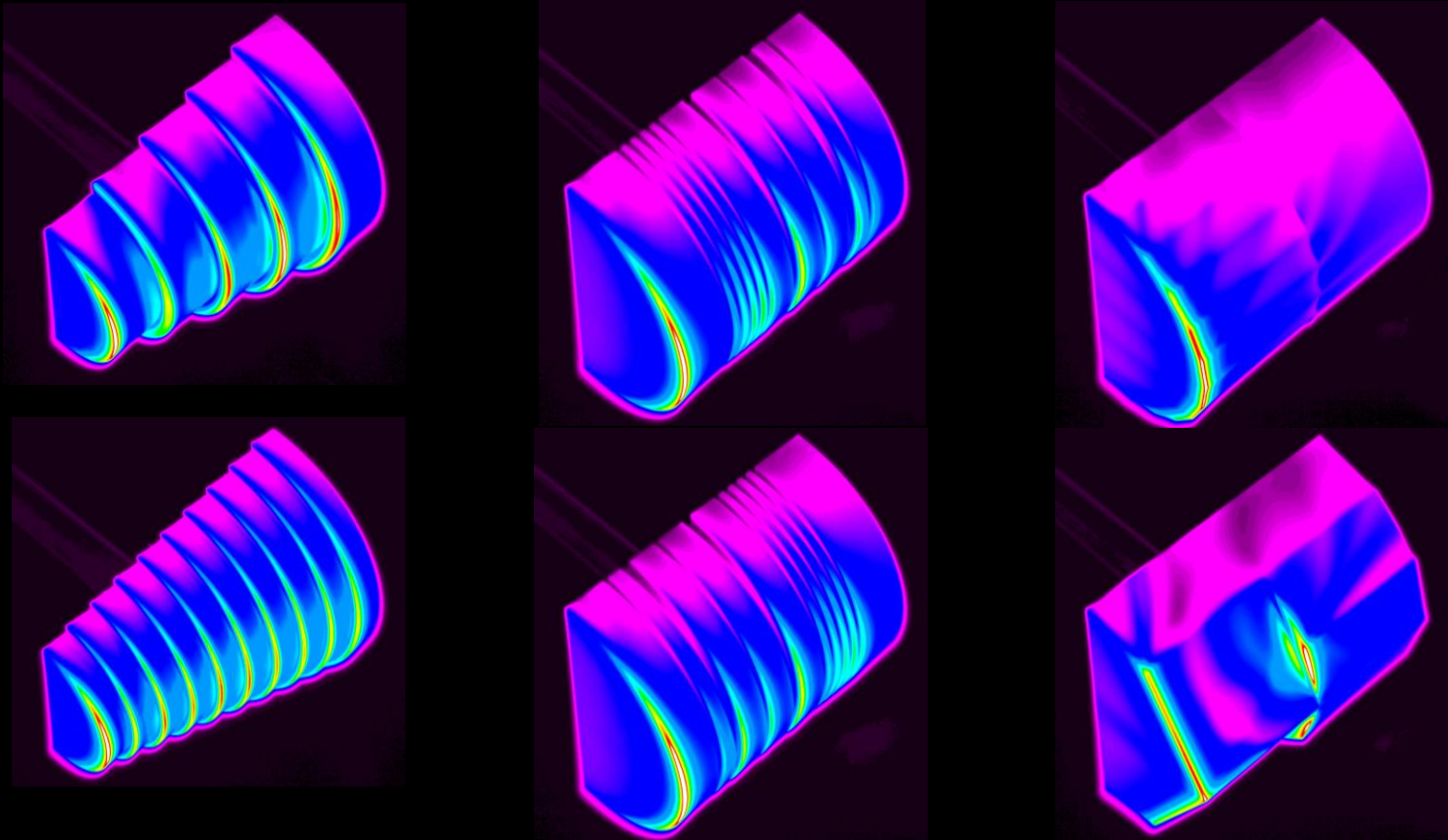
Concepts

- Four concepts selected for testing
 - Literature and component applicability
 - Holes based on 120° sphere section
 - Grooves, steps, facets based on cylinder



H2K Results – Cylinder Geometries

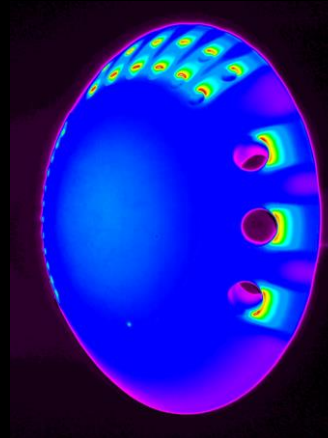
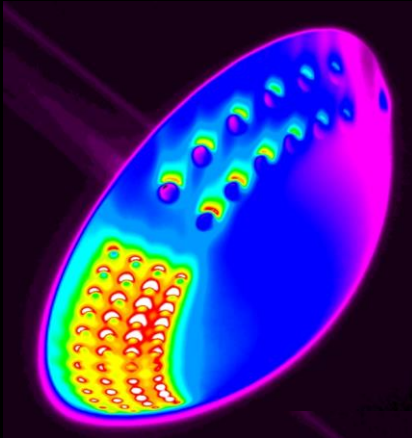
Flow 45° AoA / Top Camera



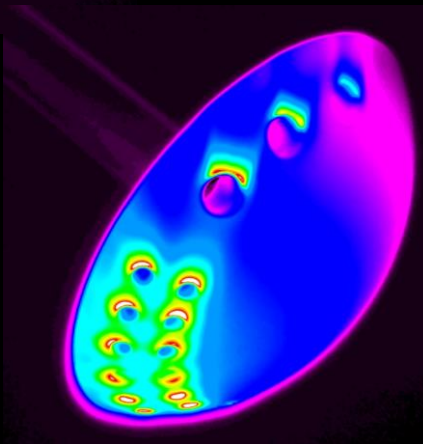
H2K Results - Holes

Flow 45° AoA / Top Camera

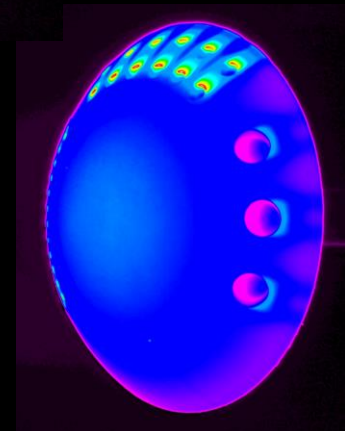
Flow 0° AoA / Side Camera



Open
holes



Blocked
holes



Down Selection

- Flux increases $>50\%$ observed (local up to factor 7!)
- Two most promising candidates selected
 - Grooves
 - Good heat flux augmentation
 - Good tumble independence
 - Relatively easy to apply to standard component shapes
 - Holes
 - Very high local heating effects
 - Significant impacts on local length scale
- Steel model selected (A316L)
 - Demise characterised material
 - Relevant to critical components (SADM, reaction wheel, OCT)

Model Design

- Models for two angles of attack

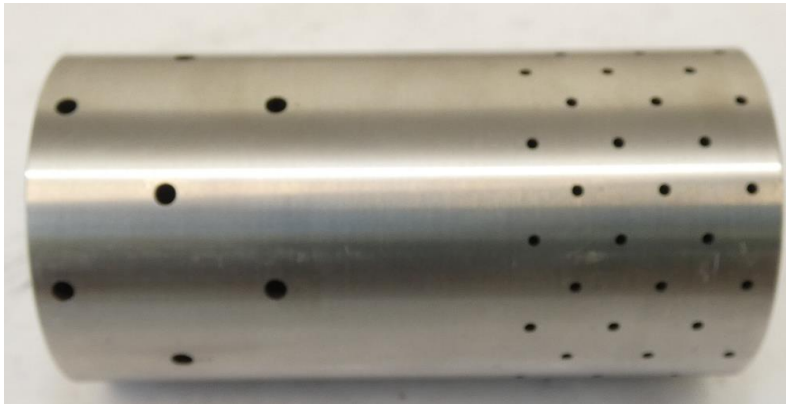
- Grooves

- 1mm
- 2mm



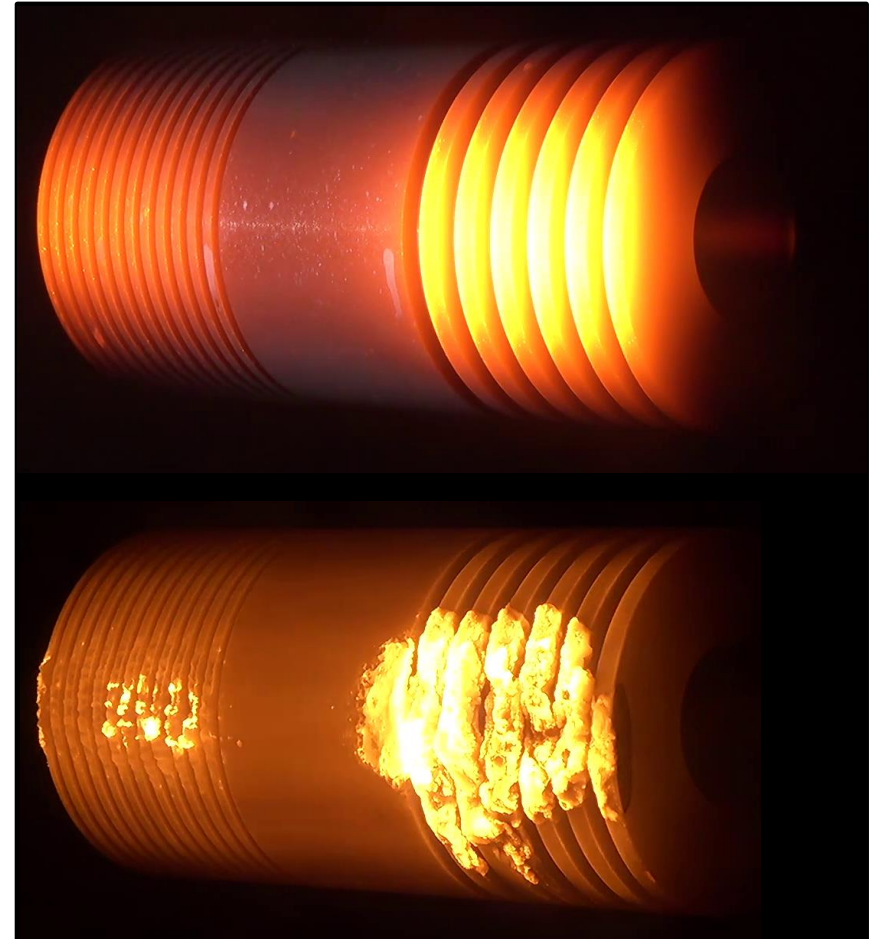
- Holes

- 1mm
- 2mm



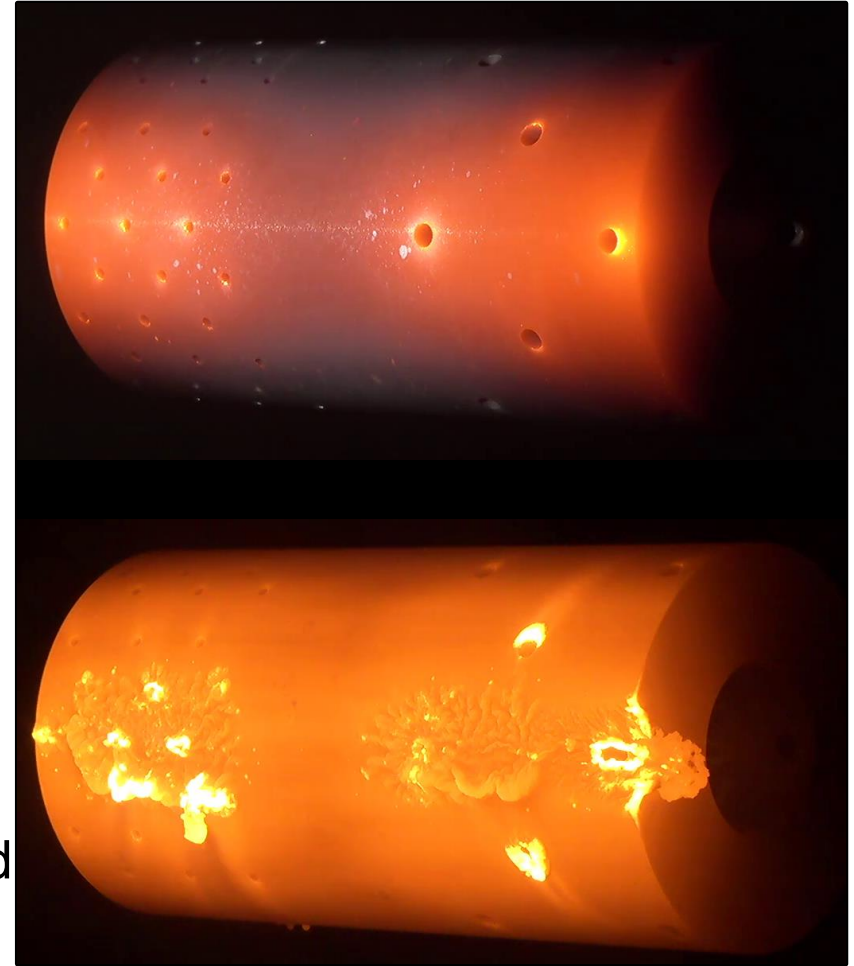
Test Campaign

- Grooved Cylinder
 - Clear heating enhancement
 - 2mm grooves clearest
 - 1mm visible impact
 - Clear order of melt
 - Use cylinder to get baseline
 - Factors
 - 1mm: 1.15
 - 2mm: 1.35
 - Significant flux increase
 - Less than suggested by H2K



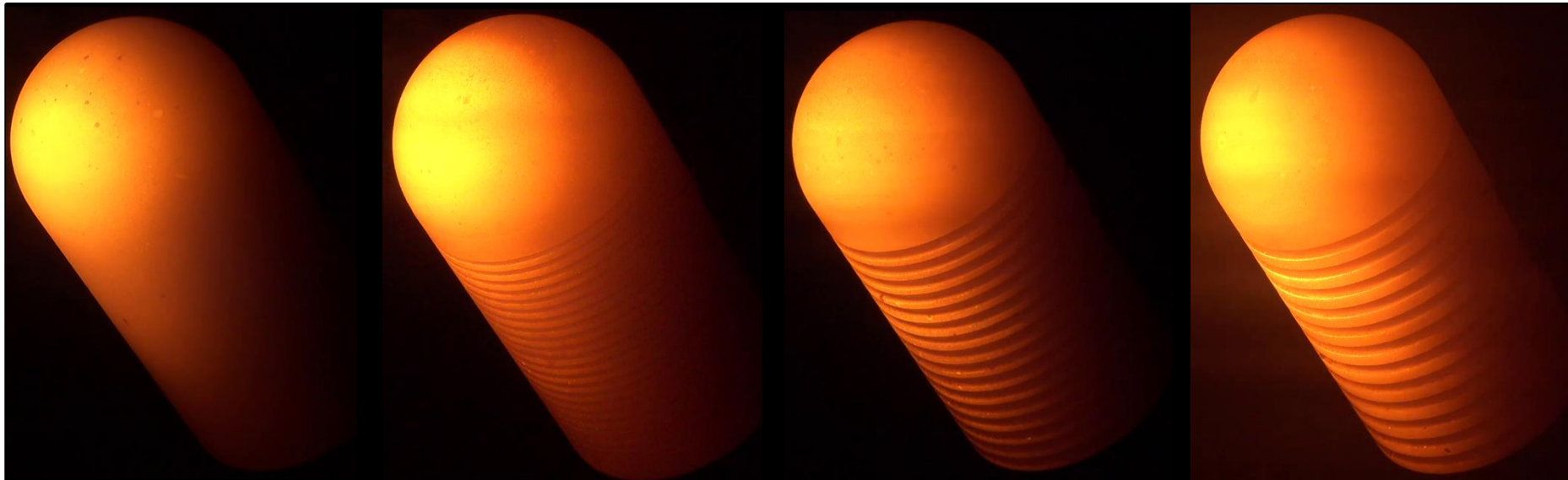
Test Campaign

- Holes Cylinder
 - Local heating impact evident
 - Also increase between holes
 - Higher local impact, smaller overall impact than grooves
 - Initial melt is at hole locations
 - Factors
 - 1mm: 1.15
 - 2mm: 1.10
 - Smaller increase
 - Again, less than H2K suggested



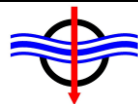
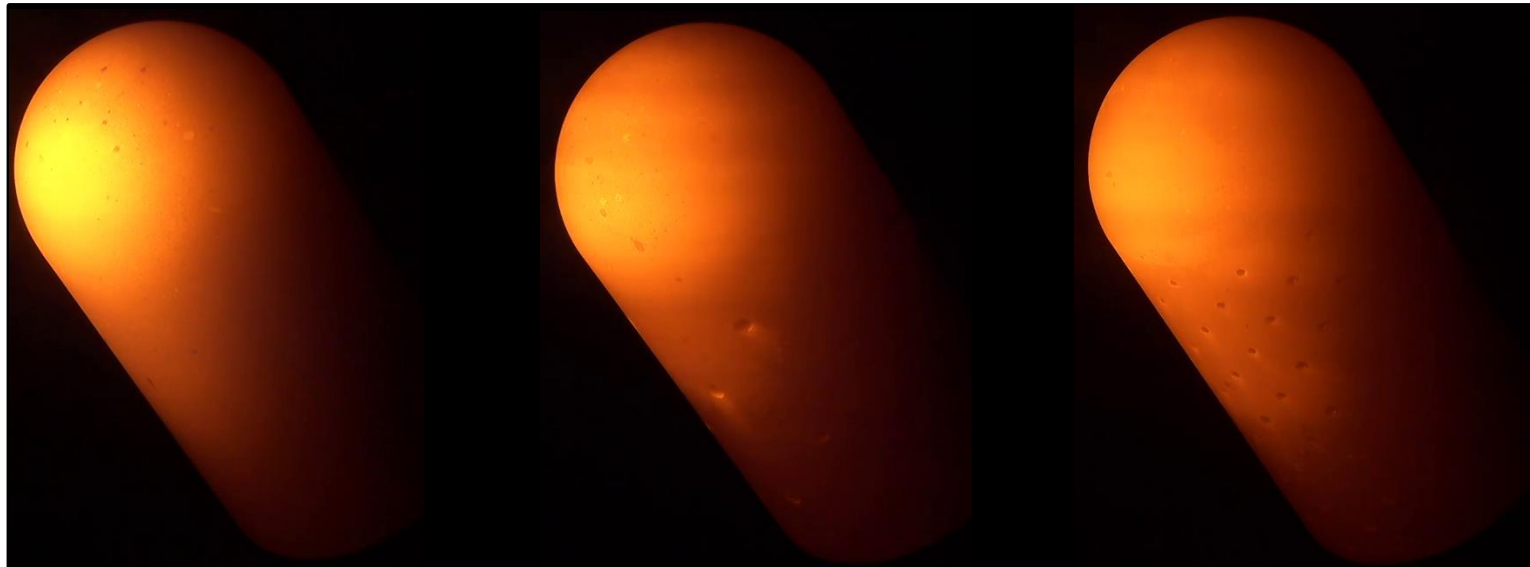
Test Campaign

- Grooved Sphere-Cylinders
 - Comparison of temperature gradients
 - Increased heating on cylinder is evident
 - Plain < 1mm < 1mm/2mm < 2mm
 - Factors; 7%, 20%, 50%



Test Campaign

- Holes Sphere-Cylinders
 - Larger impact with 1mm holes
 - Clear local heating with larger holes
 - Less effective than grooves (space between holes?)
 - Factors 6%, 12%



Conclusions

- Concept is Sound
 - Heat flux augmentation is observed
 - Strong augmentation in H2K
 - Less clear in thermocouple traces in L2K
 - Still sufficient to demise potentially critical objects
 - More work needed to understand effects

